United States Patent [19]

Proctor

[11] **3,806,945**

[45] **Apr. 23, 1974**

[54] **STRIPLINE ANTENNA**

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[22] Filed: **June 4, 1973**

[21] Appl. No.: **366,840**

[52] **U.S. Cl.**..... **343/725,** 343/767, 343/776, 333/84 M

[51] **Int. Cl.** **H01q 21/00**

[58] **Field of Search** ..... 343/725, 729, 767, 776, 343/784; 333/84 M

[56] **References Cited**

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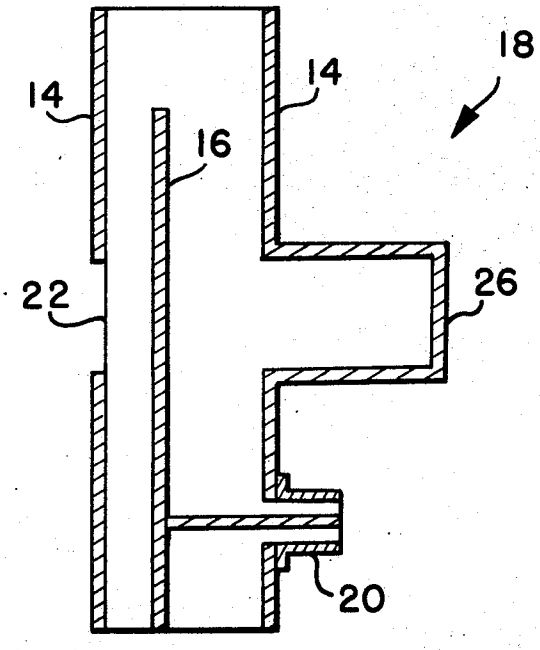
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[57] **ABSTRACT**

A stripline slot radiator for use as a flush-mounted element of a multi-function, multi-frequency, array antenna structure. A radiating slot is etched on opposite sides of both ground planes of stripline board. Radiation from the central conductor strip is restricted to one slot only by enclosing the other slot in a cavity whose sides are left open to preserve the TEM supported by the stripline.

4 Claims, 4 Drawing Figures



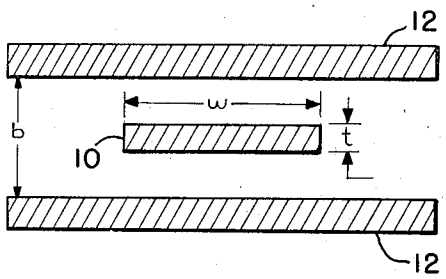


FIG. 1

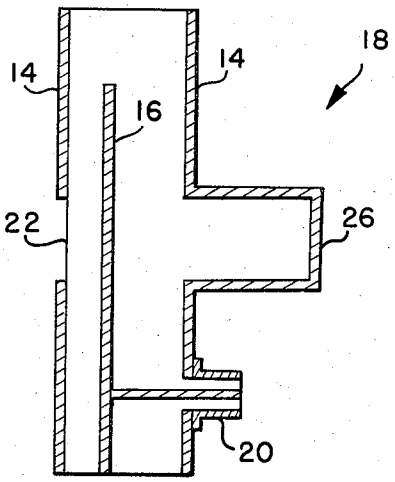


FIG. 2

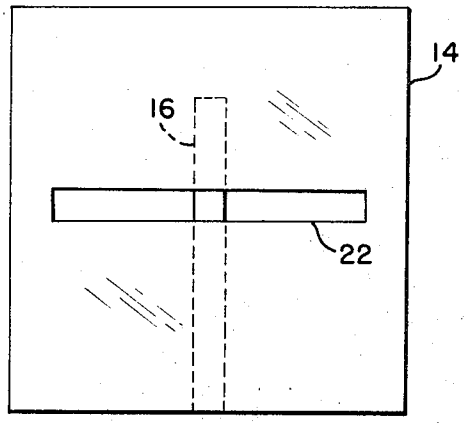


FIG. 3

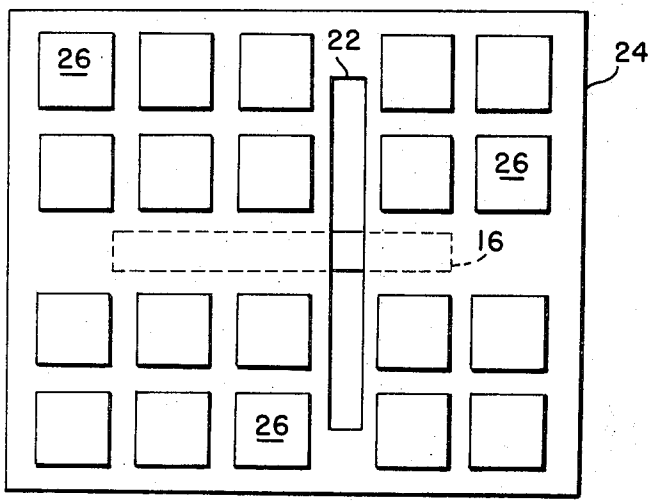


FIG. 4

STRIPLINE ANTENNA

BACKGROUND OF THE INVENTION

In an electronic system environment such as topside on naval ships, the performance of sensor and communication systems is increasingly being degraded by the number of antenna structures required to be located thereupon. Accordingly, multi-function, multi-frequency antenna structures are currently being utilized to perform, for example, radar, EW and IFF functions. Such structures comprise microwave antenna elements interlaced so as to have a common aperture and are of the type disclosed generally in U.S. Pat. No. 3,623,111. Theoretical and physical considerations restrict the types of elements that can be used for interlacing. For example, printed circuit dipoles can protrude from the aperture and thereby seriously shadow other radiating elements. Waveguide elements are cumbersome and expensive, especially in D-band and F-band. Flush-mounted elements however offer several advantages which merit their use in such structures, as will become apparent hereinafter.

SUMMARY OF THE INVENTION

A stripline radiating element for use in multi-function, multi-frequency antenna arrays is disclosed. The element is constructed from strip transmission line by symmetrically etching a slot, for radiation therefrom, in one of the two ground planes of the stripline. A similar slot is formed in the opposite ground plane to achieve a balanced electrical condition in the stripline. However, this slot is enclosed in a cavity to prevent radiation therefrom, whereby energy is radiated from the slot which is left open to the atmosphere. The resulting element radiates substantially maximum power available, and can be readily interlaced with F-band, I-band, and other radiating elements in integrated array antenna structures.

OBJECTS OF THE INVENTION

It is the primary object of the present invention to provide a stripline radiating element which can be used in a flush-mounted manner as a component of an integrated structure function antenna structure.

Another object is to provide an antenna element comprising stripline having slots on both ground planes thereof, one of which is cavity backed to allow radiation from one slot only.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of conventional stripline;

FIG. 2 is a cross-sectional view of a D-band element embodying the inventive concept;

FIG. 3 is a front view (not sectional) of the D-band element of FIG. 2; and,

FIG. 4 is a simplified illustration of a multi-frequency antenna array consisting of interlaced radiating elements, including the D-band element of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The present inventive concept will be described and disclosed, for exemplary purposes only, as a constituent radiating element of a multi-function antenna array designed to operate in the D and F frequency bands. The antenna structure can typically comprise an interlaced array **24** comprising various radiating elements as shown in FIG. **4.** In the array shown, a D-band element **22** is interlaced with a plurality of F-band elements **26** in the array. Another section of the array could contain I-band elements

The D-band portion will accommodate IFF functions whereas the F-band portion will provide coverage for a three-dimensional tracking. The I-band array can be used to provide surface search, EW, or SATCOM coverage. It should be understood that the array of FIG. **4** is merely exemplary and that other arrays could be constructed in accordance with the concept to be disclosed herein. For example, the array of FIG **4** could be constructed consisting of 128 F-band elements arranged in eight rows of 16 elements each. Interlaced between the F-band elements would be twelve D-band elements arranged in two rows of six elements each. One section of the F-band array elements could be deleted and a module of 16 I-band elements inserted therefor.

As previously stated, physical and theoretical considerations greatly restrict the choice of elements to be used in the D and F-band arrays, and stripline elements which can be flush-mounted in antenna arrays represents an ideal choice to reduce size, weight, and cost of such structures.

A strip transmission line sandwich, commonly called stripline, is shown in cross-section in FIG. **1.** As can be seen, the stripline comprises a flat conducting strip **10** located between and parallel to two conducting ground planes **12.** Generally, the stripline circuit is constructed by printing the conducting strip on one side of a section of a first, copper-clad, dielectric board. A slot for radiating energy is etched on the opposite side of the same board.

The first board is combined with a similar second board with the copper removed from one side. The two boards are thermally bonded to form the finished stripline sandwich shown in FIG. **1.** Metal screws (not shown) are finally inserted to short the two ground planes together to prevent the generation of spurious and higher order modes. If the conducting strip is small relative to the ground planes, the electric field is almost entirely confined in the dielectric, and the mode propagated in the TEM mode.

FIG. **2** represents a cross-sectional view of a D-band radiating element comprising a stripline device as shown in FIG. **1,** but having slots etched on both ground planes **14.** The slots **22** will radiate efficiently when the conductor **16** is properly excited by energy applied to the coaxial input **20.** The inner conductor of the coaxial input is connected to the strip **16** and the outer conductor is bonded to the ground plane **14.**

A stripline, in a sense, comprises a balanced circuit which supports the TEM mode. Accordingly, a slot is cut (etched) in both ground planes **14** to prevent unbalance; however, two slots permits radiation from both slots.

Consequently, to confine radiation of energy to the slot **22** only, the opposite slot is enclosed in a cavity

structure **26** as shown in FIG. **2.** For D-band, the cavity **26** is approximately a quarter-wavelength ($\lambda/4$) long and approximately doubles the slot impedance. The sides of the cavity are left open to preserve the TEM mode, and when the slot is filled with a dielectric, the slot length is increased. The conductive strip **16** extends $\lambda/4$ above the slot **22** and the bottom length of the ground plane **14** below the slot **22.**

FIG. **3** is a front view of the D-band radiating element of FIG. **2** (not sectional). In FIG. **3,** the radiating slot **22** can be clearly seen. The center strip or conductor **16** is shown in dashed lines. From FIGS. **2** and **3,** it can be seen that the device can be readily utilized in a flush-mounted manner.

Each of the F-band elements **26** of FIG. **4** comprises a rectangular waveguide fed by a probe in a conventional manner. The waveguide is cut off and terminated at one end in a metallic back plate so as to form a cavity. The probe is introduced from the back wall to facilitate array assembly. The depth of the rectangle and the two length dimensions and the diameter of the probe were adjusted empirically to obtain a matched input impedance for the coaxial line. The width and height are chosen to support the TE_{01} dominant waveguide mode and to insure linear polarization.

It can be appreciated that apparatus and techniques have been disclosed for constructing stripline antennas for use in multi-function, multi-frequency antennas. Such elements are lightweight, relatively inexpensive to manufacture, and can be readily flush-mounted in multi-frequency antenna arrays comprising interlaced radiating elements. Stripline slot radiators as disclosed are practical to use and readily constructed for use at microwave frequencies. The simplicity of their design and their ease of flush-mounting make them ideal elements for integrated antenna arrays.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A microwave radiating element comprising stripline board means having radiating slots etched in both ground planes thereof in a symmetrical manner with respect to each other and said board, cavity means enclosing one of said slots, and means connected to said board for applying microwave energy to said board for radiation thereof from said slot.

2. The element of claim **1** wherein said ground planes comprise parallel, flat plates, rigidly supported with respect to each other, and being separated from each other by a dielectric material, and wherein said energy is applied to a conducting strip positioned and rigidly supported between said ground planes.

3. A D-band radiating element comprising a rectangular stripline block having two, parallel, flat ground planes, a layer of dielectric material sandwiched between said ground planes, a conducting strip symmetrically positioned between said planes, each of said planes having a radiating slot etched thereupon, said strip extending $\lambda/4$ above said slots and extending the length of said ground planes below said slots, cavity means enclosing one of said slots, said cavity means being $\lambda/4$ long, and coaxial means for energizing said conducting strip to radiate energy from the unenclosed slot, said coaxial means including an inner conductor connected to said strip and an outer conductor connected to one of said ground planes.

4. An integrated function antenna array comprising a substantially rectangular unitary structure comprising a plurality of columns of end-fed rectangular waveguides, said columns being disposed and rigidly supported in a contiguous manner with respect to each other, said waveguides being flush-mounted with respect to the front end of said unitary structure, radiating element means comprising a substantially rectangular block of stripline having radiating slots symmetrically etched on both ground planes thereof, cavity-backed means attached to one of said slots, said radiating element means being interlaced in a symmetrical manner with respect to said waveguides, and coaxial means connected to said block for applying energy to be radiated therefrom.

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